

FIXING ROLLER SYSTEM AND METHOD

BACKGROUND

(001) This application claims the benefit of United States Provisional Application serial number 60/458,848 filed March 28, 2003.

5 (002) The invention relates to the use of roller fixing in printing. In particular, the invention relates to the use of heated rollers.

(003) Roller fusing is used for both ink jet and toner images. For example, roller fusing is often used to fix electrophotographic or ionographic toner images onto a receiver. Both heat and pressure are required. Roller fusing has also been used
10 with ink jet images and is applicable to powder coatings. For all printing methods, increased heat flow from the fuser can be used to increase process speeds, and improved heat flow may be necessary for printing on thermally conductive substrates. Temperature uniformity where the fuser roller contacts the receiver is preferred and is difficult to obtain with conventional hollow, air
15 filled fuser rollers heated internally by quartz lamps or other electrical resistance heaters.

(004) For label printing, hot foil embossing is done with a heated cylinder that has a closed hot oil circulation system. Foil is embossed onto the web under the influence of heat and pressure. Advantages include quick heating of the cylinder
20 and small temperature fluctuations.

(005) During the manufacturing process for paper, rollers heated by steam are used to dry the paper.

BRIEF DESCRIPTION OF THE DRAWINGS

(006) Fig. 1 is a schematic partial cutaway view of a fixing system for use in printing.

(007) Fig. 2 is a schematic perspective view illustrating two heated fixing rollers
5 in a fixing system.

(008) Fig. 3 is a schematic partial cutaway view of a fixing roller with selectable heating zones.

DETAILED DESCRIPTION

(009) In a printing apparatus, a fixing system 10 is provided with a fixing roller
10 12. The fixing roller 12 is heated by a recirculating fluid heat exchange medium from a reservoir 14. This heat exchange medium may be oil, water, steam, ethylene glycol, or other heated liquids, gasses, or phase change materials. The heat exchange fluid in the reservoir 14 is heated by a heater 16, which may be, for example, an electrical resistance heater, heat exchanger, or other heating
15 apparatus. The heater may likewise be disposed inside the fusing roller 12.

(010) A temperature monitor 18 monitors the temperature of the heat exchange medium. A pump 20 draws the heat exchange fluid through an intake 22 and provides the heated medium to the fusing roller 12. After circulating through the fusing roller 12, the heat exchange fluid is released through one or more return
20 tubes 26 back into the reservoir 14.

(011) The operation of the pump 20 and the heater 16 may be controlled by a controller 24, such as a processor, which may include a general purpose computer operated by software or a special-purpose computer or logic circuit designed to operate the fixing system 10. The controller 24 may be a control unit
25 implemented to operate an entire printing system, including the fixing system 10. In an alternative embodiment, the control unit is a simple thermostat designed to maintain the temperature of the heat exchange fluid in the reservoir 14. The

controller 24 preferably maintains the temperature of the heat exchange fluid at a temperature setpoint or within a temperature range.

(012) The reservoir 14 may take a variety of forms such as an unsealed sump as illustrated in Fig. 1, a sealed boiler, a coil of tubes, or other arrangement
5 selected to complement the choice of heat exchange fluid and type of heater 16 selected.

(013) As illustrated in Fig. 2, two fixing rollers 28, 30 may be used together to provide heat to a receiver, such as a sheet of paper, on which an image has been printed. Separate pumps 32, 34 may be provided for each respective roller
10 28, 30 to pump the heat exchange fluid to and through the fixing rollers. Alternatively, a single pump may be employed, with fluid distribution to the rollers 28, 30 being accomplished by valves or other means. The heat exchange fluid supplied to the rollers 28, 30 is drawn through intake tubes 36, 38 that preferably are supplied from the same reservoir (such as the reservoir 14 of Fig. 1) to limit
15 the temperature differential between the two fusing rollers 28, 30. The controller 24 may operate the pumps 32, 34. Although the pumps are illustrated as being positioned on the supply side of the rollers, it should be noted that the pumps may be positioned on the return side of the rollers.

(014) In a method of operating a fixing system, a receiver 66 on which text
20 and/or images have been printed by, for example, inkjet, electrographic, or other means is passed between the fixing rollers 28, 30 to fix the marking material (for example ink, dye, and/or toner) applied to the receiver. This may involve fusing, in the case of toner or another fusible material. The fixing rollers 28, 30 are maintained at a selected temperature or within a selected temperature range by
25 heat from a heat exchange fluid pumped through tubes 40, 42 to the fixing rollers 28, 30. After flowing through the fixing rollers 28, 30, the heat exchange fluid exits the rollers through return tubes 44, 46 to be returned to the reservoir (not illustrated in Fig. 2) and reheated.

(015) A heat load required of the fixing system 10 may vary depending upon a variety of parameters, including a speed at which receivers 66 are passed through the fixing system 10, the type of receiver 66 passed through the fixing system 10, and the type of marking material passed through the fixing system 10.

5 Therefore, according to a further aspect of the invention, the fixing system 10 may be controlled while taking these factors into account. For example, the flow rate of the heat exchange medium may be controlled to be proportional to a speed at which receivers 66 are passed through the fixing system 10. According to a further example, certain receivers may require more heat energy for proper
10 fixing than others, and a temperature of the heat exchange medium may be controlled dependent upon a type of receiver 66 passed through the fixing system 10 so that more or less heat energy is available, as needed. Furthermore, certain marking material may require more heat energy for proper fixing than others, and a temperature of the heat exchange medium may be
15 controlled dependent upon a type of marking material passed through the fixing system 10 so that more or less heat energy is available, as needed. These control concepts may be implemented alone, in combination with one or more of the others, or with other fixing system control parameters.

(016) As illustrated in Fig. 3, a fixing system for use with a printing apparatus is
20 provided, comprising a fixing roller 48 operative to fix marking material to a receiver 66, and a first heating zone 70 within the fixing roller 48 biased toward the receiver 66. For example, the fixing roller 48 has an axis of rotation and the first heating zone is displaced toward the receiver 66 away from the axis of rotation. At least a second heating zone 72 may be provided within the fixing
25 roller biased toward the receiver 66. This allows a variable heating zone to be selected so that portions nearest to a receiver 66 are selectively heated. The heat exchange fluid, such as hot oil, may be supplied in the center of the roller 48 through a fluid supply tube 54. Narrow-zone return tubes 58a, 58b and wide-zone return tubes 60a, 60b are positioned within the roller 48. Flow through the
30 narrow-zone return tubes 58a, 58b is controlled respectively by the valves 50a, 50b. Flow through the wide-zone return tubes 60a, 60b is controlled respectively

by the valves 52a, 52b. The valves 50a, 50b, 52a, 52b may be operated manually or they may be operated automatically by the controller 24 (Fig. 1).

(017) The flow of heat exchange medium may be controlled as a function of a width of the receiver 66. The first heating zone 70 and second heating zone 72
5 may correspond to different width receivers.

(018) In an exemplary use of the roller 48 in a fusing system, the valves 52a,b are closed, while the valves 50a,b are open, so that heat exchange fluid flows from the supply tube 54 to the narrow-zone return tubes 58a, 58b. The arrows 68 provide a simplified illustration of the path of heat exchange fluid flow. The
10 fluid flows primarily over a narrow zone of the roller 48 nearest the receiver 66. If a larger receiver is used, such as the receiver 66', the valves 50a,b may be closed, and the valves 60a,b may be opened to enable heat exchange fluid to flow over the entire zone of the roller 48 that is adjacent to the larger receiver 66'.

(019) In alternative embodiments, the roles of the return tubes and the supply
15 tube may be reversed to reverse fluid flow while allowing for a selectable zone of heating, or the return tubes may be positionable within the roller 48 to provide for adjustments of the heating zone size. Additional return tubes may also be provided at different locations within the fuser roller 48.

(020) Circulation, convection, and thermal conductivity of the heat exchange
20 medium in a fuser contributes to the ability to control the temperature of the fuser roll, to provide uniform temperature across the fuser, and to promote heat flow. With a circulating liquid or phase change material, relatively thin walled tubing can be used for the fuser and temperature uniformity is promoted by circulation in the roller adjacent the receiver. The thin wall of the roller further promotes heat
25 flow from the medium to the receiver. If a phase change material such as steam is used as the heat exchange fluid, heat is released during condensation on the cooler areas of the roller, providing good heat up times, temperature uniformity, and heat flow for areas on the roller surface that, for example, are conducting heat to the receiver. If phase change materials are used, the return tubes may

be provided with one or more collection tubes to collect liquid from the inside of the fuser roller. For example, the fuser roller may be provided with grooves running circumferentially on the inner surface of the roller, with collection tubes in each groove.

- 5 (021) A controller and supporting software are implemented to control the various functions described herein. Such implementation is well within ordinary skill in the relevant art. It should be understood that the programs, processes, methods and apparatus described herein are not related or limited to any particular type of computer or network apparatus (hardware or software), unless
10 indicated otherwise. Various types of general purpose or specialized computer apparatus may be used with or perform operations in accordance with the teachings described herein. The control implementation may be expressed in software, hardware, and/or firmware.

- (022) Although the invention has been described and illustrated with reference
15 to specific illustrative embodiments thereof, it is not intended that the invention be limited to those illustrative embodiments. Those skilled in the art will recognize that variations and modifications can be made without departing from the true scope and spirit of the invention as defined by the claims that follow. It is therefore intended to include within the invention all such variations and
20 modifications as fall within the scope of the appended claims and equivalents thereof. The claims should not be read as limited to the described order or elements unless stated to that effect. In addition, use of the term "means" in any claim is intended to invoke 35 U.S.C. §112, paragraph 6, and any claim without the word "means" is not so intended.